ATM Addressing in Federal Networks

White Paper

Joint Engineering Team

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This white paper has been prepared by a team of experts selected from LSN member agencies. The composition of the team changed slightly during the drafting process and additional input was often sought and recieved from other government and industry experts. Major team contributors that indicated concensus with the recommendations of the paper are listed. This list may be augmented in the future.

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1. SUMMARY

This paper discusses addressing of Federal ATM networks. Federal network planners and implementers need a ready source of ATM addresses for use in ATM networks. This paper recommends short, mid and long term approaches for addressing Federal ATM networks. These recommendations are guidelines and are not mandatory for Federal agencies. It does not preclude Federal agencies from using other addressing schemes. These recommendations are intended to interwork and be compatible with other commercial and private address structures.

Appropriate guidelines are suggested for the use of GOSIP NSAP addresses as a short term approach for ATM networks that are not using switched ATM services or that need little or no connectivity with other private ATM networks. GOSIP NSAP addresses are not recommended for a long term solution to ATM addressing since they do not provide for scaleable aggregation. GOSIP NSAP addresses also have a limited amount of address space for global network topology layout. The initial use of ATM Service Provider addresses is suggested for ATM networks that are using a single ATM Service Provider's switched services and that do not have large connectivity requirements to other ATM networks. Additional guidelines are included for the use of the suggested short term approaches to minimize the impact of any future renumbering actions.

As Federal networks begin to become richly interconnected, address aggregation between separate Federal ATM networks will become more important. As more Federal ATM networks begin to use switched ATM services and develop more connectivity with other private ATM networks, the need and complexity of address interworking increases. Global, any to any, reachability over ATM Service Provider networks will place very heavy demands on address interworking between global ATM Service Providers and on individual Federal ATM networks. For these reasons, it is suggested that Federal networks eventually use ATM addresses from a common Federal ATM addressing plan. Two such addressing plans are presented in this paper for evaluation by Federal agencies and other interested parties. One proposed plan is based on the use of existing telephone numbers that uses the existing ICD addressing space (AFI/IDI = 47/0005) owned by the U.S. government (NIST), but using a different portion of this address space than the existing GOSIP NSAP scheme. The other proposed plan is based on IPv6 global unicast addresses using a new AFI/IDI = 35/0000 address space, part of which will be owned by the U.S. government (NIST). Both are intended to be administered by the GSA. Both plans are intended for use by only Federal ATM networks. Both addressing plans rely on geographic address aggregation to improve routing but both allow some address space for organizational assignment. For comparison, a DoD ATM Addressing plan developed by DISA and currently under consideration for DoD wide use is presented.

This paper recommends, as a long term approach, the use of a common addressing plan by all Federal ATM networks and the use of bi-level addressing when required for interworking with ATM Service Provider networks. Among directly interconnected Federal ATM networks the use of unique and globally aggregatable addresses from a Federal ATM addressing plan is the preferred long term approach. However, large global Federal ATM networks will likely have to support a variety of ATM addresses, including Federal, ATM Service Provider and other private addresses. Since Federal ATM networks must also interwork with global ATM Service Provider networks, this paper recommends that Federal ATM networks also support bi-level addressing as a long term approach to global internetworking. Bi-level addressing uses two addresses for network interworking. An ATM Service Provider address is used to route between networks and a private address (Service Provider or Customer Owned) is used for routing in the destination ATM network. This approach greatly eases routing requirements by cleanly separating the topologies of both ATM Service Provider and private ATM networks. Bi-level addressing is currently being defined in the ATM Forum.

Bi-level addressing is also the only solution being considered by the ATM Forum to support rehoming (changing ATM Service Providers) and multihoming (using multiple ATM Service Providers) and address portability.

Where appropriate, the term 'private ATM network' will be used instead of 'Federal ATM network' for the remainder of this paper. ATM Service Providers worldwide will view our Federal ATM networks as private ATM networks. Also, this will help keep the perspective that our efforts should be consistent with industry addressing efforts.

2. PROBLEM STATEMENT

A proper Federal ATM addressing plan is needed to support switched connectivity between Federal networks and to enhance global reachability via ATM Service Providers to other ATM users.

Currently private ATM networks are built using various internal ATM addressing schemes. Many of these networks typically use dedicated or virtual ATM widearea service from ATM Service Providers and currently have little or no connectivity with other networks. Dedicated ATM service includes T-1, T-3 and SONET connectivity. Virtual ATM service includes ATM Service Provider Permanent Virtual Path (PVP) or Permanent Virtual Channel (PVC) service. Some private ATM networks are beginning to use Switched Virtual Channel (SVC) service from ATM Service Providers for widearea connectivity. Use of switched services will require addressing interworking. As more private ATM networks begin to use switched ATM services and more private ATM networks need interconnectivity with other private ATM networks, the need and complexity of address interworking increases. Global, any to any, reachability over ATM Service Provider networks will place very heavy demands on address interworking between ATM Service Providers and private ATM networks worldwide.

Although it is unlikely that a single government ATM backbone will exist in the near future, many Federal agencies with large ATM networks will have widearea ATM backbones. In addition, business needs will require varying degrees of interconnectivity among and between our separate ATM networks. This interconnectivity will consist of both dedicated and switched services from ATM Service Providers. It is possible that more formalized interconnect schemes may be needed for our Federal networks in the future. It will become increasingly likely as the scope of interconnected Federal ATM networks grows substantially over the next several years, that it may become necessary to define a Federal connectivity plan in concert with a Federal ATM addressing plan. For instance, it might be appropriate to establish Federal or regional exchange points, to provide for necessary route aggregation and topological continuity.

A flexible Federal addressing plan that aggregates well between separate Federal networks is needed to support this expected inter-agency connectivity and global, any to any, connectivity. A well managed, consistent Federal addressing plan is needed now to provide a source of ATM addresses for Federal network planners. This will facilitate implementation and the rapid growth of Federal ATM networks. A well-constructed plan will reduce, if not eliminate, the expense and disruption of costly renumbering operations.

3. ADDRESSING REQUIREMENTS & CRITERIA

Important ATM addressing needs include the following:

1. To support global connectivity, ATM addresses assigned to private ATM networks should be globally unique.
2. To ensure global uniqueness, ATM addresses must be well controlled, well administered and readily available to private ATM network operators. ATM addresses should be controlled by an appropriate government body (NIST controls the GOSIP NSAP address space). Address administration should be centralized and straightforward (GSA currently administers the GOSIP NSAP address space). The allocation of ATM address space to private network operators should permit local customer site address administration to the extent practical.
3. To support growth of individual sites and worldwide extension of private ATM networks, the addressing plan must be scaleable.
4. To minimize routing complexity within each private ATM network, between private ATM networks, and to other non-government ATM networks, a hierarchical addressing structure should be developed that aggregates equally well within each private networks as well as between separate private networks. (Choices may have to be made between geographical, functional and organizational hierarchies.)
5. To support global connectivity over public ATM networks, an ATM addressing plan should be compatible with addresses supported by the public ATM network.
6. To provide for acquisition flexibility and cost effective operation, an ATM addressing plan should support rehoming and multihoming within a private ATM network. These capabilities would support adding, changing or dropping ATM service providers with little or no impact on the internal addressing or topology of the private ATM network.
7. An ATM addressing plan should support special needs, such as security, portability of network nodes and terminal mobility. This is particularly important to organizations that have to support highly sensitive or mobile operations, such as the Department of Defense. These needs are also important to Federal organizations that need to respond to natural disasters and emergencies.

4. ADDRESSING OPTIONS

The ATM Forum has defined two categories of addresses and two different addressing methods. The two categories of addresses are ‘Service Provider Addresses’ and ‘Customer Owned Addresses'. Service Provider Addresses are ATM addresses owned by an ATM Service Provider that can be used in a private network. E.164 addresses (native or AESA format) are, by definition, Service Provider Addresses, but any AESA format (including ICD and DCC) owned by an ATM Service Provider is considered an Service Provider Address. Customer Owned Addresses are ATM addresses owned by private network operators that are obtained by a recognized registration authority. GOSIP addresses, administered by GSA for NIST, are considered Customer Owned Addresses.

The two basic addressing methods are referred to as ‘single-level’ and ‘bi-level’ addressing. The single-level method means that only one ATM address (AESA or native E.164) is needed to route a call to its destination. This is the preferred method of operation and it should be possible between different private networks that use addresses from a hierarchical addressing plan or that use only ATM Service Provider Addresses. To enhance global routing of ATM addresses, it is important to keep the number of globally routeable addresses to a minimum. The ATM Forum has agreed that ATM Service Providers are only required to carry Service Provider Addresses and not Customer Owned Addresses (unless special arrangements are made with individual service providers). However, two important private network capabilities, ATM Service Provider rehoming and multihoming, are not currently defined for private networks that use ATM Service Provider Addresses. Using ATM Service Provider Addresses will require address change when rehoming to another ATM Service Provider. Likewise, there is no clear procedure defined for multihoming (using multiple ATM Service Providers) if a private network uses ATM Service Provider Addresses. To address these concerns, the ATM Forum is defining a bi-level addressing method, which uses two addresses: a service provider AESA (or native E.164) to route the call between global networks, and a destination AESA to route within the destination private ATM network. The destination AESA could be a Customer Owned or Service Provider Address. Bi-level Addressing is scaleable and supports both rehoming without private network readdressing and multihoming to multiple service providers.

4.1. Addressing Plans for Private Networks

Private ATM networks should use Service Provider Addresses or Customer Owned Addresses. Networks using Customer Owned Addresses may decide to use bi-level addressing to support rehoming and multihoming needs.

4.1.1. Service Provider Addresses

Service Provider Addresses include native E.164 numbers and the NSAP formatted ATM End System Addresses defined by the ATM Forum (E.164 AESA, ICD AESA and DCC AESA). Since E.164 numbers are only available to ‘public’ ATM Service Providers, native E.164 and E.164 AESA addresses are always Service Provider Addresses. Service Provider Addresses can also be ICD AESA and DCC AESA if this address space is owned by the respective Service Provider. Appendix I contains some examples of Service Provider Addresses. These include an E.164 AESA and an ICD/DCC AESA format.

4.1.2. Customer Owned (Private) Addresses

Private ATM addressing plans use ATM Forum defined NSAP formatted ICD or DCC ATM End System Addresses. The only existing plan in North America is the GOSIP ICD addressing plan. Private ATM network operators can obtain their own ICD address space from the British Standards Institute through the American National Standards Institute (ANSI) or their own DCC address space directly from ANSI. However, Federal ATM network operators should consider using a single addressing scheme to support address aggregation between separate ATM networks.

4.1.2.1. Existing NSAP Addresses (GOSIP)

The GOSIP NSAP addressing plan is currently administered by the Government Services Administration (GSA) for NIST. Although intended for a general source for NSAP addresses, it has been used by many organizations as a source for ATM addresses. Appendix II gives a brief description of the GOSIP NSAP addressing plan.

4.1.2.2. New Proposed Federal ATM Addressing Plans

Two proposed plans are presented for evaluation. One is based on the existing ICD format controlled by NIST (AFI/IDI = 47/00 05) and is differentiated from the GOSIP plan by using a different high order nibble following the three octet AFI/IDI. There is ample space in the existing government owned ICD format (AFI/IDI = 47/00 05) and there is no need to get a new ICD or DCC address space. The other plan is based on a new addressing plan (AFI/IDI = 35/00 00), which is used to embed an IPv6 aggregatable global unicast address. Additional plans were also considered. It was generally agreed that a better addressing plan might be possible later, after connectivity between Federal ATM networks and with ATM Service Providers matures. The plans presented in this paper are the best possible with available information and they both meet all basic requirements. Both plans would benefit from a well developed connectivity plan which could use an exchange based or a regional based aggregation scheme. The development of this connectivity plan is beyond the scope of this paper. Both of these plans are for evaluation and comment by Federal agencies and other interested parties. The two plans are:

1. A telephone-like numbering plan, based on the well controlled existing worldwide international E.164 numbering plan is presented in Annex A.
2. An addressing plan based on hierarchical IPv6 aggregatable global unicast addresses, and which is currently under development, is presented in Annex B.

4.1.3. Bi-level Addressing

The ATM Forum is defining a bi-level addressing method, which uses two addresses: a service provider AESA (or native E.164) to route the call globally, and a destination AESA for routing in the destination network. Bi-level Addressing is scaleable and supports both rehoming without private network readdressing and supports multihoming to multiple service providers. The bi-level method works with single addressing.

An example of bi-level addressing would be to use a destination customer owned address (such as an address from one of the Customer Owned (private) addressing plans previously mentioned) and a destination ATM Service Provider access address. All Federal networks would address their networks with addresses from a common Federal plan (Customer Owned Addresses) or with Service Provider Addresses. For every access to an ATM Service Provider, a unique Service Provider Address would be assigned. Private networks directly connected to one another could simply use single-level addressing. However, connectivity over ATM Service Provider networks may require the use of bi-level addressing.

5. RECOMMENDATIONS

The following are recommendations for ATM addressing of Federal networks. Many of these recommendations apply to private ATM networks as well. A list of issues considered is contained in Annex C. General recommendations will be followed by short, mid and long term recommendations. The following are general recommendations:

1. It is recommended that our private networks use AESA formatted addresses and not use Native E.164 addresses since most Federal networks will be built using PNNI protocols that only support AESA formats.
2. Assignment should be done on a geographic basis as the best overall approach to support a high degree of aggregation between multiple networks. However, organizational assignment should be available and used where needed. Private networks using organizational assignments should only advertise their organizational prefix and should have adequate backbones to do internal routing of traffic. Also, using organizational assignments may limit the ability to use cost effective ATM switching.
3. Geographic assignment of AESAs should be done on a site by site basis. The exact definition of a 'site' is not firm. It could be a building, campus or base. All ATM switches at a site could be expected to have the same ATM Service Provider access points and have a single ATM site prefix.
4. Any AESA prefix used by our private networks should guarantee the unrestricted use of, at least, the last two (2) and possibly three (3) prefix octets for site topology layout by the private network operator. This should hold for ATM Service Provider Addresses or addresses from a Federal addressing plan. This will separate local site topology from backbone topologies. This approach will minimize the impact of any future renumbering requirements. Although renumbering will require readdressing switches, it should not require the reengineering of the site topology.
5. Non Federal organizations and sites can use the same or similar approaches for addressing as described in this document. In some cases, non Federal sites may obtain addresses from a sponsoring Federal organization. Nothing in this paper precludes non Federal organizations from creating their own addressing plan. They also can obtain their addresses from an ATM Service Provider or an appropriate addressing authority.
6. An appropriate Federal body should consider the need for a Federal connectivity and address implementation plan.

5.1. Short Term Approach

The recommended short term approach is that assignment be done on a site by site basis using either our existing ICD, GOSIP format or ATM Service Provider Addresses. If Service Provider Addresses are used it is recommended that E.164 AESAs be used when available because they are geographic and are likely to come with some degree of connectivity. These are the only options available to Federal ATM network operators at this time for use on operational networks. This is not meant to preclude short term experimental approaches such as the IPv6 addressing option. GSA will relax the GOSIP format to allow the full use of octets 8 to 13 by the assigned Administration Authority (Section 10, Appendix II).

Sites and organizations using Service Provider or GOSIP for ATM addressing should be prepared to change addresses in the future. Service Provider addresses will have to be changed when it becomes necessary to change service providers or additional Service Provider access points are added. The GOSIP NSAP format has limited space, only six (6) octets, to construct a global topology.

For the short term sites should ensure their address space reserves at least two octets (Octets 12 and 13) for their local site topology. Two octets of site topology provides for the equivalent of 65,536 subnets, each of which can have a large number of ATM switches. Through proper use of variable length subnetting to allocate appropriate size blocks of addresses to different parts of the organization of various sizes, it should be possible to accommodate most sites with two octets. For those relatively few extremely large sites, or those with complex internal topologies, they can expand out to the use of three octets. This approach will minimize the impact of renumbering on the local site topology when addresses are changed.

To improve the scalability of interconnected Federal ATM networks in the near term, and to provide time to evolve the Federal ATM addressing plan in an orderly manner, individual sites should, in general, not acquire their own ATM address space, but should instead use address space of their private network operator where possible. For example, this means that sites should not generally acquire their own GOSIP addresses, but should use a subdelegation of the GOSIP address space obtained by their Federal network operator. Some possible exceptions to this general guideline could include organizations that actually provide network transit service, sites that need to be multihomed, or sites that have other special requirements such as experimenting with ATM signaling or routing protocols.

If a Federal network decides to use ATM Service Provider AESAs, the E.164 AESA format is recommended since they aggregate geographically and will likely have some connectivity structure associated with them when they become available. Other proprietary ATM Service Provider AESA formats may be used as an interim approach, with the understanding that future renumbering may be needed in the mid term by changing to an E.164 AESA or Federal AESA plan when available. Any agreement with a service provider for use of their E.164 or proprietary AESA format should guarantee the private network use of the last two to three prefix octets.

5.2. Mid Term Approach

As more Federal networks interconnect and begin to use switched ATM services from ATM Service Providers, it becomes more important to have a common addressing plan. Although this paper does not discuss connectivity issues, using a single plan may enhance routing between Federal ATM networks and possibly over ATM Service Provider ATM networks. Therefore, suggest that Federal sites should use a common Federal addressing plan. Recommend that Federal private networks use address space from a Federal addressing plan in a manner to facilitate address aggregation between interconnected Federal private networks and to support ease of service provider rehoming and multihoming. Although organizational assignment is supported, this option should be used judiciously, since if agencies use organizational assignment of an inappropriate geographic scope, it may introduce many different high order prefixes, and these addresses will not scale well and will not aggregate well between networks.

Two different Federal addressing plans are presented in section 4 that meet our basic criteria outlined in section 3. Comment and opinion are requested from our Federal agencies and from interested service providers and vendors. A number of key issues and doability concerns are identified in Annex C and comments are welcome on any other pertinent matter. Once this input has been received, our intent is to pick the most acceptable plan for use by our private networks.

5.3. Long Term Approach

The recommended long term approach is to use Federal ATM addresses for routing among interconnected Federal networks and to use bi-level addressing for global connectivity across ATM Service Provider networks. Using bi-level addressing separates site and organizational topologies from ATM Service Provider routing topologies, and supports rehoming and multihoming. Recommend supporting the development of bi-level addressing specifications at the ATM Forum and standard bodies (ANSI, ITU). The bi-level approach uses two addresses to establish connections between private networks over ATM Service Provider networks. Bi-level addressing uses a Service Provider Address to route calls across ATM Service Provider networks and a destination address (typically an AESA) that uniquely identifies a user within a private ATM network. The use of bi-level addressing offers the most flexibility for both ATM Service Provider and private network operators. Using a common Federal addressing plan will facilitate address aggregation between interconnected private ATM networks. However, when bi-level addressing becomes widely available, any unique addressing space, ASP or customer owned will work equally well over ATM Service Provider networks.

ANNEX A: Existing ICD, Telephone-Like Numbering Plan

1.1. Introduction

The following proposed addressing plan is based on international telephony numbers and organizational designators. The plan aggregates globally and is easy to administer. It provides for both geographic and organizational area assignments. The following structure of this addressing plan is discussed below. The attached chart shows the different possibilities under this plan.

Geographical assignments to individual sites are preferred and provide reasonable aggregation between different private networks under normal interconnection scenarios. As in the current telephony numbering plan, the North America geographic portion (P2) is a subset of the International geographic portion (P1). This plan provides adequate space for local site topology, three (3) octets for North American sites and two (2) octets for international sites.

Although geographical site assignment is preferred, this plan provides for organizational addressing. Organizational addressing space is provided for the following areas (the number of octets available for network topology is provided in parenthesis): P3 - international (8) and for North America P4 - national (7), P5 - regional (6). Although organizational assignments may be needed in some cases, they should only be used where appropriate. Organizational addressing will not aggregate well between separate private ATM networks. Other ATM networks will only deliver calls to the nearest interconnection to a private ATM network using organizational addressing. Thus, a private ATM network using organizational addressing must have an adequate backbone so that all addresses in the network can be reached from every interconnect point. Assigning ATM addresses by organization rather than geographically may be more costly to network operators because of the increased routing complexity between organizations and through commercial networks. The following diagram shows the rough relationship between the different options available under this plan.

```
                         Existing ICD IDI
                           /           \
  (P1) International Geographic   (P3) International Organizational
                      \
               North America (NA)
               /              \
    (P2) NA Geographic    NA Organizational
                           /              \
             (P4) NA National   (P5) NA Regional
```

The likely assignment procedures for this plan areas follows. GSA will administer the assignment of addresses under this plan to Federal ATM network operators on a site by site basis. The Federal ATM network operator will provide GSA a phone number for each site needing addresses. GSA will provide an appropriate address from this addressing plan. If the Federal ATM network operator has connectivity needs to ATM Service Provider networks, then GSA will provide the Federal ATM network operator a list of recommended ATM Service Providers from an approved Federal ATM connectivity plan, when available.

1.2. Common Format

```
|| 1 | 2 | 3 || 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 ||14-19 |20 ||
||AFI|  IDI  ||             DSP                            || ESI  |SEL||
||   |       ||   |   |   |   |   |   |    |    |    |    ||      |   ||
||47 | 00 05 ||4|x|x|x|x|x|x|x|x|x|x|x| x|x| x|x| x|x| x|x||x....x| xx||
              ^
```

Government Identification nibble (4 bits) for ATM format

Note: this is different from '8' used in GOSIP (DFI = 80)

AFI = 47, Use existing ICD value, 1 Octet

IDI = 00 05, Use the existing government owned IDI, 2 Octets

ESI/SEL = End Station NIC address & selector octet, 7 Octets

DSP = 10 octets encoded as follows:

First nibble = 4, Government NSAP format indicator for ATM End System Address.

Second nibble = (Indicator for geographical or organizational format.)

0, Reserved - Not Used.

1-9, fist Digit of E.164 Country or Region Code, examples:

1 for North America, 4(9) for Germany, and 8(1) for Japan.

A (hex) International Organizational Format

B-F Reserved, should be 0.

Third nibble - the end =

continuation of country code based on second nibble, or

Start E.164 - the address in BCD format and be padded with trailing 0's, or

Partial E.164 followed by A (hex) and organizational address.

Unless otherwise indicated, the following notations are used in sections 6.2.1 - 6..2.5:

x - don't care, 0's if not used

R - Reserved, 0's unless specified

S - Site Topology

C - Customer Organization Indicator - 1 & 1\2 Octets

N - Network Topology of a Customer Organization

T - E.164 Telephony Number

1.2.1. P1 - International Geographic Option

International Telephone Number BCD encoded, left adjusted

Leaves Two (2) Octets for Site Topology

```
 || 1 | 2 | 3 || 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 ||14-19 |20 ||
 ||   |        ||   |   |   |   |   |   |    |    |    |    ||      |   ||
 ||47 | 00 05 ||4|T|T|T|T|T|T|T|T|T|T|T| T|T| T|T| S|S| S|S||x....x| xx||
                 ^
Example:         4 4 1 7 1 2 5 0 6 2 2  3 x  x x
```

Where:

44	UK Country Code,
171	London Exchange,
250-6223	Local Number,
xxx	Padding, all zeros.

1.2.2. P2 - North America Geographic Option

North America Telephone Number BCD encoded, left adjusted

Leaves Three (3) Octets for Site Topology

```
 || 1 | 2 | 3 || 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 ||14-19 |20 ||
 ||   |        ||   |   |   |   |   |   |    |    |    |    ||      |   ||
 ||47 | 00 05 ||4|T|T|T|T|T|T|T|T|T|T|T| R|R| S|S| S|S| S|S||x....x| xx||
                 ^
Example:         1 7 0 3 2 8 4 8 2 2 6
```

Where:

1	North America,
703	Northern Virginia,
284-8226	Local Number,
RR	Padding, all zeros

1.2.3. P3 - International Organizational Option

International Organizational Indicator BCD encoded, left adjusted

Leaves Eight (8) Octets for Organizational Network Topology

```
 || 1 | 2 | 3 || 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 ||14-19 |20 ||
 ||   |        ||   |   |   |   |   |   |    |    |    |    ||      |   ||
 ||47 | 00 05 ||4|x|x|x|N|N|N|N|N|N|N|N| N|N| N|N| N|N| N|N||x....x| xx||
                 ^
Example:         A C C
```

Where:

A	Organizational Code Indicator,
CC	International Organization Code.

1.2.4. P4 - NA (North America) National Organizational Option

NA Country Code & Organizational Code, left adjusted

Leaves Seven (7) Octets for Organizational Network Topology

```
|| 1 | 2 | 3 || 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 ||14-19 |20 ||
||   |       ||   |   |   |   |   |   |    |    |    |    ||      |   ||
||47 | 00 05 ||4|1|x|x|x|R|N|N|N|N|N|N| N|N| N|N| N|N| N|N||x....x| xx||
                    ^
Example:          1 A C C
```

Where:

1	North America
A	Organizational Code Indicator,
CC	North American Organization Code.

1.2.5. P5 - NA (North America) Regional (State) Organizational

Option

NA Country & Area Code & Organizational Code, left adjusted

Leaves Six (6) Octets for Organizational Network Topology

```
|| 1 | 2 | 3 || 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 ||14-19 |20 ||
||   |       ||   |   |   |   |   |   |    |    |    |    ||      |   ||
||47 | 00 05 ||4|1|T|T|T|x|x|x|N|N|N|N| N|N| N|N| N|N| N|N||x....x| xx||
                          ^
Example:          1 7 0 3 A C C
```

Where:

1	North America
703	Northern Virginia
A	Organizational Code Indicator,
CC	Regional Organization Code.

ANNEX A

Annex B: New AFI 35, IPv6

This plan embeds an IPv6 address into an AESA, using an AFI/IDI of 35/0000. Implementation of this addressing plan is tied to the ongoing evolution of IPv6 addressing.

With this scheme, once a site had a validly assigned IPv6 address from GSA, it would also have a valid ATM address that would have the same aggregation properties as the associated IPv6 address. In the short term, testing can be done using other, non-GSA (Federal) IPv6 addresses.

See the Internet Draft draft-ietf-ipngwg-unicast-aggr-00.txt, "An IPv6 Aggregatable Global Unicast Address Format", for details about the IPv6 addressing scheme. See also the Internet Draft draft-ietf-ipngwg-testv2-addralloc-00.txt, "IPv6 Testing Address Allocation", for information on the use of IPv6 test addresses. Both of these efforts are currently works in progress, although the Internet Draft on the IPv6 aggregatable global unicast addresses should become a Proposed Standard as one of the base IPv6 RFCs in the not too distant future. It is not yet clear how long it will take for official IPv6 registries to be established, so use of the IPv6 based ATM addressing scheme will currently require use of the IPv6 test addresses, which means renumbering of addresses would be required at some later date whenever official IPv6 addresses became available.

The likely assignment procedures for this plan are as follows. NIST will obtain a block of IPv6 addresses from IANA. GSA will administer the assignment of addresses under this plan to Federal ATM network operators on a site by site basis. Some designated Federal entity, to be determined by the Large Scale Networking Group, shall provide GSA with a Federal connectivity plan[1] for use in assigning addresses from this plan. The Federal ATM network operator will provide GSA with site information and connectivity information for each site needing addresses. GSA will provide an appropriate addresses from this addressing plan.

```
|| 1 | 2 | 3 || 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 ||14-19 |20 ||

||AFI|  IDI  ||FP/TLA |     NLA(s)     | SLA(s)  | Reserved|| ESI  |SEL||

||35 | 00 00 ||x x|x x|x x|x x|x x|x x|x  x|x  x| xx | xx ||x...x | xx||

||           ||   IPv6 Site Prefix    |Subnet ID|    Interface ID |SEL||
```

AFI = 35, Provisionally Assigned to IANA.

IDI = 00 00, Indicates IPv6 address embedded in AESA

DSP

FP = 001 (binary), 3 bits. Format Prefix for IPv6 aggregatable global unicast addresses

TLA 13 bits. Top-Level Aggregator.

NLA(s) 32 bits. Next-Level Aggregator(s) (Octets 6-9)

SLA(s) 16 bits. Site-Level Aggregator/Subnet ID (Octets 10 & 11)

Note: `Site use can be expanded to three octets (9-11)`

Reserved 16 bits. Not used for topology. (Octets 12 & 13)

ESI 6 octets, End System ID

SEL 1 octet, Selector

---

[1] Using this scheme, it would probably be beneficial for the Federal networks to use the exchange based option for the IPv6 aggregatable global unicast addresses. This would provide for provider independence. To completely insure provider independence, it may be necessary for the Federal network confederation to manage and operate its own set of exchange points, such as at the GigaPops or similar locations.

ANNEX C: ISSUES

Following are a list of Issues and Doability concerns. There are three categories of addressing plans mentioned in section 4. They are service provider plans, existing and proposed Federal only plans and bi-level addressing. These plans, particularly the Federal Addressing Plans should be compared to the following issues and doability concerns.

The issues are critical items that may eliminate some of our options from consideration. The doability concerns need to be considered in writing for the options that remain.

1.1. The issues:

8.1.1. Global Hierarchy (Geographical, Organizational, Functional)

8.1.2. Site topology (2 or 3 octets?)

8.1.3. Ease of Assignment & Administration (Global, Centralized, Site)

8.1.4. Service Provider Independent (Multihoming & Rehoming)

8.1.5. Network Management

1.2. Some doability concerns:

8.2.1.) service provider support

8.2.2.) equipment support

8.2.3.) user acceptable addresses (DNS? ANS?)

8.2.4.) network management impact

8.2.5.) renumbering technology / flexibility

8.2.6.) interim (can be done quick) vs. long term (what needs to be pursued)

8.2.7.) Global reachability

8.2.8.) Scaleable (can get as big as you want)

8.2.9.) Routing efficiency (?)

8.2.10.) Economic (cheap? expensive?)

8.2.11.) Impact on security

8.2.12.) Acquisition flexibility

8.2.13.) Portability/Mobility

8.2.14.) Federal Only (or Shared?)

Appendix I: Service Provider Addresses

Following are examples of Service Provider ATM addresses.

1.1. E.164 AESA based on native E.164 numbers

Note: Not yet available in North America

```
|| 1 || 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 || 10 | 11 | 12 | 13 ||14-19 |20 ||
||AFI||              IDI              ||       HO-DSP      || ESI  |SEL||
||45 ||SP |SP |SP |SP |SP |SP |SP |SP || ?? | ?? | ST | ST ||x...x | xx||
```

Where SP = Service Provider and ST = Site

AFI = 45

IDI = Native E.164 number assigned by the service provider

number is right adjusted with some fill

HO-DSP = High Order - not yet defined but likely for

customer site topology - use right two octets

ESI 6 octets, End System ID

SEL 1 octet, Selector

1.2. ICD/DCC AESA (based on AT&T information)

```
|| 1 | 2 | 3 || 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 ||14-19 |20 ||
||AFI|  IDI  ||             HO-DSP         |<<<<|Customer || ESI  |SEL||
||x x|SP |SP ||SP |SP |SP |SP |SP |SP | SP | ?? | ST | ST ||x...x | xx||
```

AFI = 47 (ICD) or 39 (DCC) or other

IDI = assigned to the service provider

DSP = High Order - service provider owned (topology)

Customer = Two/Three octets for customer site topology

ESI 6 octets, End System ID

SEL 1 octet, Selector

Appendix II: Existing Federal GOSIP NSAP Addressing Plan

RFC1629 (Guidelines for OSI NSAP Allocation in the Internet)

Controlled by NIST and Administered by GSA

```
|| 1 | 2 | 3 || 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 ||14-19 |20 ||
||AFI|  IDI  ||DFI|    AA     |  Rsvd |   RD    |   Area  || ESI  |SEL||
||47 | 00 05 ||80 |xx |xx |xx |ST |ST | ST | ST | ST | ST ||x...x | xx||
```

IDP Initial Domain Part

AFI = 47, Authority and Format Identifier

IDI = 0005, Initial Domain Identifier

DSP Domain Specific Part

DFI = 80 DSP Format Identifier (GOSIP)

AA Administrative Authority (Assigned by GSA)

Rsvd Reserved

RD Routing Domain Identifier

Area Area Identifier

ESI 6 octets, End System ID

SEL 1 octet, Selector

"In the low-order part of the GOSIP Version 2 NSAP format, two fields are defined in addition to those required by IS-IS. These fields, RD and Area, are defined to allow allocation of NSAPs along topological boundaries in support of increased data abstraction. Administrations assign RD identifiers underneath their unique address prefix (the reserved field is left to accommodate future growth and to provide additional flexibility for inter-domain routing). Routing domains allocate Area identifiers from their unique prefix".

Appendix III: DoD ATM Address Plan Recommendation (9/8/97)

(Currently under Standards Coordinating Committee Consideration)

1.1. Purpose.

To describe the DoD Asynchronous Transfer Mode (ATM) Address Plan to which the DoD Addressing Working Group (WG) of 11-12 June 1997 agreed.

1.2. Summary.

The DoD Addressing Working Group agreed to a DoD ATM Address format that

1) Uses the Network Service Access Point (NSAP) International Code Designator (ICD),
2) Uses the Initial Domain Identifier (IDI) 0006,
3) Applies meaning to the fourth octet for non-ATM technologies,
4) Adopts a geographical hierarchy in the WAN,
5) Includes three levels of hierarchy in WAN,
6) Supports tactical requirements,
7) Includes a globally unique tactical switch identifier between the WAN and site parts of the address,
8) Does not include organizational significance as part of the NSAP,
9) Reserves three octets for site use, and
10) Shall be independent of the Federal ATM NSAP plan.

1.3. Description.

The following diagram depicts the fields of the DoD ATM NSAP Address format.

DoD ATM NSAP Address

```
/-------------------------------------------------------------------------------\
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
|---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---|
|    IDP    |                                                                   |
|-----------+-------------------------------------------------------------------|
|AFI|  IDI  |        DSP                                                        |
|---+-------+---+---------------+---+---+-----------+-----------------------+---|
|47 | 0006  |FI |Routing Domain |GUI|Rsv|   Area    |       System ID       |n-S|
|---+-------+---+---------------+---+---+-----------+-----------------------+---|
|   |       |   |RD1|RD2|RD3|RD4|   |   |           |                       |   |
\---+-------+---+---+---+---+---+---+---+-----------+-----------------------+---/
```

DoD ATM NSAP Field Semantics

IDP	Initial Domain Part, an NSAP address structure specified by the International Standards Organization (ISO), contains the subfields AFI and IDI.
AFI	Authority and Format Identifier, the value of 47 indicates that the IDI part is interpreted as a four decimal digit ICD and that the DSP is represented in binary.
IDI	Initial Domain Identifier, the ISO assigned the ICD value 0006 to be administered by the National Institute of Standards and Technology (NIST) which has then delegated all authority to the Department of Defense (DoD) under the title "USA DoD OSI Network."
DSP	Domain Specific Part, authority for structure and assignment of DSP values is delegated by ISO to the organization defined by the IDP (in this case, to NIST and then to DoD). The Defense Communications Agency (DCA), renamed as the Defense Information Systems Agency (DISA), is the named authority for DoD. The management responsibilities delegated by NIST to DoD require that DoD register the DSP structure for ICD 0006 with NIST.
FI	Format Identifier, identifies syntax and associated semantics encoded within an NSAP address. Administrative authority associated with specific FI code points currently applies only to DISA.
RD	Routing Domain, uniquely identifies a Routing Domain within the Administrative Domain specified by ICD 0006 and FI. DISA assigns the RD values.
RD1	Level 1 Routing Domain, a pre-identified non-overlapping geographic region, generally not attached to subscriber equipment.
RD2	Level 2 Routing Domain, a pre-identified non-overlapping geographic RD1 subregion, associated with a MAN or concentration of DoD bases.
RD3	Reserved for expansion of either the RD2 or RD4 domains.
RD4	Level 4 Routing Domain, usually associated with a specific subscriber site.
GUI	Globally Unique Identifier, uniquely identifies an administration authority for deployed networks. DISA assigns values and delegates authority for the GUI to the Deployed Networks Administration Authority.
Rsv	Reserved for additional semantics or the expansion of the GUI or Area fields.
Area	Area, uniquely identifies a subdomain of the RD/GUI, DISA delegates authority for administration and semantic assignment of the Area field to the Deployed Networks Administration Authority or to the Site Administration Authority.
System ID	System Identifier, identifies a unique system within an Area.
n-S	NSAP Selector, identifies a direct user of the network layer service, usually a Transport entity.

NSAP DSP Field Values and Semantics

Field	Value (Hex)	Semantic
FI	1	Command & Control networks using ATM.
RD1	00 - 0f	Reserved.
	10 - 7f	Major geographic regions such as the Middle Atlantic, Northeast, Southwest, Midwest, Southeast, Northwest, West Coast, Pacific, Europe, and Central/South America.
	80 - ff	Reserved
RD2	00 - ff	Subordinate geographic region, MAN or concentration of DoD bases. Shall not be further subdivided.
RD3	00 - ff	Reserved for expansion of either the RD2 or RD4 domains.
RD4	00 - ff	DISA assigns values sequentially from available space to uniquely identify DISN ATM Service Delivery Point edge switches in RD2 subregions.
GUI	00	DISA assigns this value to DISN ATM Service Delivery Point edge switches.
	01 - 0f	Reserved.
	10 - 1f	Available for subscriber networks in the process of transitioning to DISN.
	20 - 80	Reserved.
	81 - ff	DISA assigns values sequentially from the available space to identify an administration authority for deployable networks. The value is globally unique within the FI value equal to 1.
Area	any value	DISA delegates authority over the format and semantic content of the Area field to the Deployed Networks Administration Authority or the Site Administration Authority. The authority is responsible for ensuring uniqueness within an RD/GUI subdomain.
System ID	any value	The authority is responsible for ensuring uniqueness within an Area subdomain.
n-S	any value	DISA delegates authority over the format and semantic content of the n-S ID field to the Deployed Networks Administration Authority or the Site Administration Authority for standard acceptable values.

1.4. Discussions.

The proposed DoD NSAP Address plan is discussed against the following requirements.

1) Support for Global Connectivity

The address plan is based on the International Code Designator (ICD) format and uses Initial Domain Identifier (IDI) value of 0006, which was assigned to DoD by the British Standards Institute in 1988. This provides global uniqueness, which is necessary for global connectivity.

2) Minimized Routing Complexity

The address plan uses three level of geographical hierarchies. This supports a high degree of address aggregation and simple routing.

3) Support for Scalability

The plan is highly scalable. It has 8 octets-wide address space for DoD ATM switches, which is twice the size of the current internet address space.

4) Interworking with Public Networks

Interworking with public networks is supported. When interworking with public networks, the DoD NSAP Address will constitute the lower 20 octets of the 20 + 20 address format.

5) Independence from Service Providers

Change of the ATM service providers will not affect DoD switches nor DoD users under this plan. As mentioned before, the service provider address will be the high order 20 octets of the 20 + 20 address format.

6) Support for Tactical Users

The tactical ATM switches are supported in a manner similar to the tactical circuit switches. The address plan supports global uniqueness of tactical switches independent from the routing domains. This allows tactical switches to be reconfigured by simply plugging in the prefix of the destination. Since each tactical switch is global unique among the tactical switches, each is “pre-deconflicted”.